

National Aeronautics and Space Administration

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Marshall Space Flight Center, AL 35812



March 20, 2017

Reply to Attn of:

EV44 (17-002)

TO: KSC-SII30/Lisa Huddleston

FROM: EV44/Barry C. Roberts

SUBJECT: March 2017 Meteorological Support Interface Control Working Group  
(MSICWG) Instrumentation, Data Format, and Networks Document

The attachment to this memorandum contains contractor report ESSSA-FY17-903 "March 2017 Meteorological Support Interface Control Working Group (MSICWG) Instrumentation, Data Format, and Networks Document".

The MSICWG is led by the National Aeronautics and Space Administration (NASA) Marshall Space Flight Center (MSFC) Natural Environments Branch. The working group includes representatives from NASA's Johnson Space Center, Kennedy Space Center (KSC) and MSFC, and the Air Force Eastern Range (ER). The MSICWG meets monthly to discuss the status of weather instrumentation located at the Air Force ER and KSC in support of NASA space launch activities at KSC and the ER. Topics include the coordination in the format and distribution of weather measurements and associated products between NASA and the ER.

The purpose of the attachment is to document, as of March 2017, the current state of meteorological instrumentation, data formats and local computer network configurations as discussed at the MSICWG meetings.

Please contact Barry C. Roberts at 256-544-6124 or James Brenton at 256-544-9142 if there are any questions concerning the attached report.

A handwritten signature in black ink, reading "Barry C. Roberts". The signature is written in a cursive, flowing style.

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A handwritten signature in black ink, reading "B. Glenn Overbey". The signature is written in a cursive, flowing style.

B. Glenn Overbey  
Chief, Natural Environments Branch

Attachment:

MSICWG Instrumentation Data Format and Networks Document

cc:

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# **March 2017 Meteorological Support Interface Control Working Group (MSICWG) Instrumentation, Data Format, and Networks Document**

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## **1.0 Introduction**

The purpose of this document is to provide an overview of instrumentation discussed at the Meteorological Interface Control Working Group (MSICWG), a reference for data formats currently used by members of the group, a summary of proposed formats for future use by the group, an overview of the data networks of the group's members. This document will be updated as new systems are introduced, old systems are retired, and when the MSICWG community necessitates a change to the formats.

The MSICWG consists of personnel from the National Aeronautics and Space Administration (NASA) Kennedy Space Center (KSC), NASA Marshall Space Flight Center (MSFC), NASA Johnson Space Center (JSC), National Oceanic and Atmospheric Administration National Weather Service Spaceflight Meteorology Group (SMG), and the United States Air Force (USAF) 45<sup>th</sup> Space Wing and Weather Squadron. The purpose of the group is to coordinate the distribution of weather related data to support NASA space launch related activities.

## **2.0 Instrumentation Overview**

This section provides an overview of the instrumentation, coordinated through the MSICWG, used to generate weather data.

### *2.1 WINDS Tower, including LC39-B Met Instrumentation*

The Weather Information Network Display System (WINDS) provides meteorological data from 46 towers located within the United States Air Force Eastern Range (ER), KSC and nearby area. The towers vary in height and meteorological measurement capabilities. For instance, Tower 313 is the only tower that has the ability to measure atmospheric pressure. However, almost all towers have the instruments to measure wind speed, wind direction, temperature, and dew point. Several WINDS towers are associated with launch complexes such as Launch Complex 39-B (LC39-B).

### *2.2 KSC TDRWP*

The KSC Tropospheric Doppler Radar Wind Profiler (TDRWP) measures wind speed and wind direction from 1,795-19,430 meters. The TDRWP is located near the Space Shuttle Landing facility at the site of the former system, the 50-MHz DRWP. Several configurations changes have been made during the transition from the 50-MHz DRWP to the TDRWP. The TRDWP uses a four beam configuration and operates at 48-MHz. Profiles are generated every 5 minutes, and each profile contains 119 range gates spaced by approximately 150 meters. In addition to wind speed and direction, the TDRWP output file contains signal power, noise level, spectral width, number of first guess propagations, and a quality control flag.

### *2.3 915-MHz DRWP*

A network of five 915-MHz DRWPs are operated by the ER and are located throughout the KSC and Cape Canaveral Air Force Station (CCAFS) area. These DRWPs report wind speed and wind direction from 130 to 6,100 meters. This altitude range provides coverage from the highest recorded values from the WINDS towers to the lower portion of TDRWP profiles. The 915-MHz DRWPs operate in a three beam configuration with one vertical beam and two orthogonal oblique beams. Profiles from each DRWP are generated every 15 minutes and contain 60 range gates spaced by approximately 100 meters.

### *2.4 AMPS Flight Elements*

Two types of Automated Meteorological Profiling System (AMPS) flight elements exist; Low Resolution Flight Elements (LRFE) and High Resolution Flight Elements (HRFE). The LRFE use a standard latex weather balloon with a Global Positioning System (GPS) tracked sonde that contains sensors for temperature and relative humidity. Wind measurements from the balloon are computed from the balloon's horizontal position as measured by the GPS. Altitude is directly measured from the GPS. The low resolution balloons can reach an altitude of over 100,000 feet.



In addition to the AMPS HRFE, radar tracked Jimspheres are used to produce high resolution wind profiles. Both the Jimsphere and HRFE use a spherical balloon with small cone-like protrusions over the surface to reduce self-induced balloon motions. However, the flight elements differ in how the position is tracked. Jimsphere balloons have a reflective aluminized coating so that their position can be tracked by radar. HRFEs are made of a clear plastic and are tracked by a GPS unit on the flight element. Because the balloon's volume remains constant throughout ascent, high resolution balloons typically reach their maximum altitude below 60,000 feet.

## *2.5 4DLSS*

The 4 Dimensional Lightning Surveillance System (4DLSS) consists of two systems: the Lightning Detection and Ranging (LDAR) system for detecting lightning aloft and the Cloud to Ground Lightning Surveillance System (CGLSS). LDAR has an array of nine sensors which analyzes lightning events up to 100 kilometers in all directions from a central location at KSC. LDAR uses sensors to detect radio pulses from step leaders and other in-cloud lightning mechanisms. Each sensor provides a possible location for a single lightning event and a statistical Chi-Squared minimization is calculated to determine the most likely location of the event from the nine sensors. CGLSS utilizes a network of gated, broadband electric and magnetic field sensors to detect the waveform signatures that are characteristic of return strokes, the high-current components of cloud-to-ground flashes.

## *2.6 MERLIN*

Mesoscale Eastern Range Lightning Information Network (MERLIN) detects and locates both Cloud-to-Ground and Intra-Cloud lightning and generates two separate sets of data. MERLIN uses ten Total Lightning Sensor (TLS)-200 sensors. The system is used to ensure the safety of personnel and assets for launches and launch operations. Current plans are for MERLIN to replace 4DLSS once MERLIN is operationally accepted.

## *2.7 LPLWS -field mill & rain gauge network*

The Launch Pad Lightning Warning System (LPLWS) is a network of 31 electrostatic field sensors housed in field mills, each measuring the vertical component of the electrostatic field. Each mill uses a rotating and grounded metallic shutter to alternately cover and uncover a set of insulated stators that respond to the vertical component of the electrostatic field. The two dimensional maps produced by the mills show approximately where the cloud charges are located. Rain gauges are co-located with the field mills, providing hourly and daily rainfall totals.

## *2.8 ER C-Band Weather Radar*

The USAF ER C-Band Weather Radar has a range of 250 nautical miles and is used for severe weather and flash flood warnings, launch support, and resource protection at the ER.

### 3.0 Current Data Formats

This section gives an overview of current data formats used for weather data generated by the instrumentation described in the proceeding section. Many of the files are in their respective Meteorological Data Transfer Format (MDTF). Figures with an example of the header and data from these file formats are included. In addition to the example figures, there exist tables describing the header, data, and termination lines for each source that uses the MDTF.

Each table contains the following fields: “Field”, “Columns”, “Contents”, “Field Definition”, “Units”, and “Format Read Statement”. “Field” uses a combination of alphabetical and numerical characters to define the order of each field and the line number of the variable, respectively. For example, the termination altitude of the TDRWP is listed as B250, meaning the termination altitude is the second field on the 250<sup>th</sup> line of the file. “Columns” lists the exact columns that contain the values. The column characters are inclusive and begin with 1. “Contents” gives an example of what each character of the field contains. If the field is an unchanging string, such as a header descriptor, that string is provided in single quotations. If the field is a variable integer or float the potential characters are listed as an X, and the placement of the decimal is used to illustrate the precision of the floating value. “Field Definition” provides a description for each field. “Units” provides the units used by each field variable. “Format Read Statement” provides the Python formatted read statement for each field. Given the information found in the table, equivalent “Format Read Statements” for other programming languages such as Matlab, C, and FORTRAN can be written.

These tables only include the sources supported by MDTF. The parent documentation for MDTF, JSC-22955 Rev B, has been retired. Further information on all other formats, such as the formats used by MERLIN and the LPLWS, can be found on the KSC Weather Archive webpage. All figures in this document have had data removed for brevity. Ellipses are used to indicate where data were removed.

### 3.1 WINDS Tower, including LC39-B Met Instrumentation

The WINDS Towers data are disseminated through Range External Interface Network (REIN) in the tower specific MDTF. WINDS tower data is collected in one and five minute intervals, where each interval has an average and peak wind speed and respective wind direction. In both the one and five minute interval data files, the peak wind speed and respective direction from the past ten minutes is included. The first line of the header contains the file name, which consists of location, day of the year, and transmit time of the file. Each line of data after the header is an individual height from a tower. For instance, Tower 108 has three altitudes at which data is recorded, so there exist three lines of data for Tower 108. The last line of the file is a file termination flag. Each line also has an 80 character limit. These files are created and disseminated every minute for one minute WINDS intervals and once every five minutes for five minute WINDS intervals. In Figure 1 and other figures that show data in specified formats, the ellipsis is used to indicate that data has been removed for brevity.

WT012722020														
CCAFS/KSC WIND TOWER DATA														
2020Z 29 SEP 15														
		01 MIN		01 MIN		10 MIN								
		AVERAGE		PEAK		PEAK								
TOWER	HGT	AV	DIR	SPD	DIR	SPD	DIR	SPD	DEV	TMP	TMP	DP	RH	PRE
	FT	MIN	DEG	KTS	DEG	KTS	DEG	KTS	DEG	F	F	F	%	MB
39 B NW	457	01	172	12	173	13	173	13	007	77.3		74.4	91	
39 B NW	458	01	159	10	152	11	160	13	007	77.8		74.3	89	
39 B NW	459	01	185	2	190	7	194	10	021	78.0		73.9	87	
39 B NW	382	01	174	12	173	13	173	13	007	77.8		72.3	83	
39 B NW	383	01	156	10	160	12	162	13	007	78.0		75.4	92	
39 B NW	384	01	164	6	172	9	181	11	009	78.1		74.9	90	
39 B NW	257	01	168	12	167	13	167	13	008	78.7		74.7	87	
39 B NW	258	01	154	10	154	12	158	12	008	78.5		75.2	89	
39 B NW	259	01	164	6	159	8	173	10	008	78.7		74.2	86	
39 B NW	132	01	170	11	170	13	170	13	007	79.3		76.1	90	
39 B NW	133	01	151	10	149	11	155	11	008	79.5		75.5	87	
39 B NW	134	01	160	7	157	9	157	10	006	79.0		75.6	89	
0108	54	01	166	6	167	8	167	9	012	79.6	-0.6			
0108	12	01	149	3	151	6	154	7	022					
0108	06	01								80.2				
...														
NNNN														

Figure 1: Example of WINDS MDTF

The tables below include the wind tower MDTF header and data formats. Even though each line number in the table is listed as seven, the data formats are repeated for each height for each tower. For example, a tower that records data at three heights will have three lines of data. The wind tower MDTF end of file flag is 'NNNN'.

Table 1: Wind Tower MDTF of Header Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A1	1-2	‘WT’	Wind tower identifier	N/A	‘%2s’
B1	3-4	XX	Wind tower location identifier	N/A	‘%2s’
C1	5-7	XXX	Day of the year	Day of the year	‘%3d’
D1	8-11	XXXX	Time, hour and minute	Time, military	‘%4s’
A2	1-9	‘CCAFS/KSC’	Location identifier	N/A	‘%9s’
B2	11-25	‘WIND TOWER DATA’	Data source identifier	N/A	‘%15s’
C2	31-34	XXXX	Observation time	Time, Hour and minute	‘%4s’
D2	35	‘Z’	Zulu time unit	N/A	‘%1s’
E2	38-39	XX	Day of month	Day of month	‘%2d’
F2	41-43	XXX	Month, abbreviated to three letters	Month	‘%3s’
G2	45-46	XX	Last two digits of year	Year	‘%2d’
A3	20-21	XX	Minute interval for averaged values	Minutes	‘%2d’
B3	22-25	‘MIN’	Minute unit identifier	N/A	‘%3s’
C3	28-29	XX	Minute interval for peak values	Minutes	‘%2d’
D3	31-33	‘MIN’	Minute unit identifier	N/A	‘%3s’
E3	36-41	‘10 MIN’	Peak ten minute interval identifier	N/A	‘%6s’
A4	20-26	‘AVERAGE’	Identifier for averaged minute interval values	N/A	‘%7s’
B4	28-31	‘PEAK’	Identifier for peak minute interval values	N/A	‘%4s’
C4	36-39	‘PEAK’	Identifier for peak values from the last ten minutes	N/A	‘%4s’
D4	56-58	‘TMP’	Temperature difference identifier	N/A	‘%3s’
A5	1-5	‘TOWER’	Tower identifier	N/A	‘%5s’
B5	13-15	‘HGT’	Height identifier	N/A	‘%3s’
C5	17-18	‘AV’	Minute interval identifier	N/A	‘%2s’
D5	20-22	‘DIR’	Minute interval average wind direction identifier	N/A	‘%3s’
E5	24-26	‘SPD’	Minute interval average wind speed identifier	N/A	‘%3s’
F5	28-30	‘DIR’	Minute interval peak wind direction identifier	N/A	‘%3s’

G5	32-34	‘SPD’	Minute interval peak wind speed identifier	N/A	‘%3s’
H5	36-38	‘DIR’	Peak ten minute wind direction identifier	N/A	‘%3s’
I5	40-42	‘SPD’	Peak ten minute wind speed identifier	N/A	‘%3s’
J5	44-46	‘DEV’	Directional deviation identifier	N/A	‘%3s’
K5	50-52	‘TMP’	Temperature identifier	N/A	‘%3s’
L5	56-58	‘DIF’	Temperature difference identifier	N/A	‘%3s’
M5	63-64	‘DP’	Dew point identifier	N/A	‘%2s’
N5	67-68	‘RH’	Relative humidity identifier	N/A	‘%2s’
O5	73-75	‘PRE’	Pressure identifier	N/A	‘%3s’
A6	13-14	‘FT’	Height unit identifier	N/A	‘%2s’
B6	16-18	‘MIN’	Minute interval unit identifier	N/A	‘%3s’
C6	20-22	‘DEG’	Minute interval average wind direction unit identifier	N/A	‘%3s’
D6	24-26	‘KTS’	Minute interval average wind speed unit identifier	N/A	‘%3s’
E6	28-30	‘DEG’	Minute interval peak wind direction unit identifier	N/A	‘%3s’
F6	32-34	‘KTS’	Minute interval peak wind speed unit identifier	N/A	‘%3s’
G6	36-38	‘DEG’	Peak ten minute wind direction unit identifier	N/A	‘%3s’
H6	40-42	‘KTS’	Peak ten minute wind speed unit identifier	N/A	‘%3s’
I6	44-46	‘DEG’	Directional deviation unit identifier	N/A	‘%3s’
J6	52	‘F’	Temperature unit identifier	N/A	‘%1s’
K6	58	‘F’	Temperature difference unit identifier	N/A	‘%1s’
L6	64	‘F’	Dew point unit identifier	N/A	‘%1s’
M6	68	‘%’	Relative humidity unit identifier	N/A	‘%1s’
N6	74-75	‘MB’	Pressure unit identifier	N/A	‘%2s’

Table 2: Wind Tower MDTF of Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A7	1-7	XXXXXXXX	Tower ID	N/A	'%7s'
B7	10-11	XX	Tower side	N/A	'%2'
C7	13-15	XXX	Height of sensor	Feet	'%3d'
D7	17-18	XX	Minute averaging interval	Minutes	'%2d'
E7	20-22	XXX	Average wind direction	Degrees	'%3d'
F7	24-26	XXX	Average wind speed	Knots	'%3d'
G7	28-30	XXX	Peak wind direction	Degrees	'%3d'
H7	32-34	XXX	Peak wind speed	Knots	'%3d'
I7	36-38	XXX	Ten minute peak wind direction	Degrees	'%3d'
J7	40-42	XXX	Ten minute peak wind speed	Knots	'%3d'
K7	44-46	XXX	Directional Deviation	Degrees	'%3d'
L7	48-52	XXX.X	Temperature	Fahrenheit	'%5.1f'
M7	54-58	XXX.X	Temperature Difference	Fahrenheit	'%5.1f'
N7	60-64	XXX.X	Dew point	Fahrenheit	'%5.1f'
O7	66-68	XXX	Relative humidity	Percent	'%3d'
P7	70-75	XXXX.X	Surface pressure	Millibars	'%6.1f'

### 3.2 KSC TDRWP

The TDRWP data is disseminated through REIN in the profiler-specific MDTF. The MDTF was developed for the previous system, the 50-MHz DRWP, thus the data fields were written to accommodate a three beam configuration; North, East, and Vertical. The TDRWP operates in a four beam configuration so the values for vertical velocity, signal power, noise level, and spectrum width are averaged to fit the profiler MDTF. Also, the file contains the maximum cross-beam first-guess propagation. As with the other MDTF files, there exists an 80 character limit to each line. The first line of the header contains the file name, which consists of location, day of the year, and transmit time of the file. The footer of the file contains metadata regarding the condition of the radar. The last line of the file is a file termination flag.

```

PS072731210
TEST NBR 02015
PROFILER DATA
KENNEDY SPACE CENTER, FL.
1209Z 30 SEP 15

  ALT  DIR  SPD  SHR  WW  S1  S2  S3  N1  N2  N3  WID1 WID2 WID3 G G QC
GEOM  DEG  M/S  /SEC  M/S  DB  DB  DB  DB  DB  DB  M/S  M/S  M/S  1 2 NN

  1798 234  14.0 .000  -0.12111.5109.9110.8 62.0 62.6 62.3  0.8  0.5 0.64 0 0 64
  1948 233  14.0 .001  -0.06115.0114.6114.8 62.1 62.7 62.4  0.9  0.5 0.70 0 0 64
  2098 238  14.3 .008  -0.19117.7117.3117.5 60.5 61.2 60.9  0.9  0.5 0.68 0 0 64
...
TERMINATION          19465
135.0 45.0  0.0 75.7 75.7 90.04096  30  30  30  3  3  3 153.8 153.8 153.8
150 150 150 150 150 150 640  0  250 20 3038  0  0  0 47 4 0 5
3 3 3 0 0 5
103 103
NNNN

```

*Figure 2: Example of TDRWP MDTF*

The TDRWP and AMPS Flight Elements all have uniform headers that include location, date, and time information. The table for the fixed header is included below, as well as the tables describing the MDTF format for the TDRWP header, data, and termination fields. The format in the TDRWP Data format table is repeated for each altitude of a profile generated by the TDRWP. Under nominal conditions, the TDRWP generates 119 gates of data resulting in this data format being repeated for each gate.

*Table 3: Fixed AMPS Flight Element and TDRWP Header MDTF*

<b>Field #</b>	<b>Columns</b>	<b>Contents</b>	<b>Field Definition</b>	<b>Units</b>	<b>Format Read Statement</b>
A1	1-2	XX	Equipment Type	N/A	'%2s'
B1	3-4	XX	Site Identification Code	N/A	'%2s'
C1	4-7	XXX	Julian data of file creation	Day of year	'%3s'
D1	8-11	XXXX	Zulu time of file	Hour and minute	'%4s'
A2	1-8	TEST NBR	Test Number Identifier	N/A	'%8s'
B2	10-14	XXXXX	Test Number	N/A	'%5s'
A3	1-80	String varies in length	Measuring equipment header	N/A	'%80s'
A4	1-80	String varies in length	Measuring site location	N/A	'%80s'
A5	1-4	XXXX	Zulu time of balloon launch or initial measurement	Hour and minute	'%4s'
B5	5	Z	Indicates Zulu	N/A	'%1s'
C5	8-9	XX	Day of month	Day of month	'%2s'
D5	11-13	XXX	Abbreviated month	Month	'%3s'
E5	15-16	XX	Last two numbers in year	Year	'%6.2f'



Table 4: TDRWP Specific MDTF Header Format

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A6	Blank line				
A7	3-5	‘ALT’	Altitude identifier	N/A	‘%3s’
B7	8-10	‘DIR’	Wind direction identifier	N/A	‘%3s’
C7	14-16	‘SPD’	Wind speed identifier	N/A	‘%3s’
D7	19-21	‘SHR’	Shear identifier	N/A	‘%3s’
E7	25-26	‘WW’	Radial velocity (vertical) identifier	N/A	‘%2s’
F7	30-31	‘S1’	Signal power of East beam identifier	N/A	‘%2s’
G7	35-36	‘S2’	Signal power of North beam identifier	N/A	‘%2s’
H7	40-41	‘S3’	Signal power of vertical beam identifier	N/A	‘%2s’
I7	45-46	‘N1’	Noise level of East beam identifier	N/A	‘%2s’
J7	50-51	‘N2’	Noise level of North beam identifier	N/A	‘%2s’
K7	55-56	‘N3’	Noise level of Vertical beam identifier	N/A	‘%2s’
L7	60-63	‘WID1’	Spectral Width of East beam identifier	N/A	‘%4s’
M7	65-68	‘WID2’	Spectral Width of North beam identifier	N/A	‘%4s’
N7	70-73	‘WID3’	Spectral Width of Vertical beam identifier	N/A	‘%4s’
O7	75	‘G’	First guess propagation of East beam	N/A	‘%1s’
P7	77	‘G’	First guess propagation of North beam	N/A	‘%1s’
Q7	79-80	‘QC’	Wind vector error estimate	N/A	‘%2s’
A8	Blank line				
A9	2-5	‘GEOM’	Geometric altitude unit identifier	N/A	‘%4s’
B9	8-10	‘DEG’	Wind direction unit identifier	N/A	‘%3s’
C9	14-16	‘M/S’	Wind speed unit identifier	N/A	‘%3s’
D9	18-21	‘/SEC’	Shear unit identifier	N/A	‘%4s’
E9	25-27	‘M/S’	Radial velocity unit identifier	N/A	‘%3s’
F9	30-31	‘DB’	Signal power of East beam unit identifier	N/A	‘%2s’
G9	35-36	‘DB’	Signal power of North beam unit identifier	N/A	‘%2s’
H9	40-41	‘DB’	Signal power of Vertical beam unit identifier	N/A	‘%2s’
I9	45-46	‘DB’	Noise level of East beam unit identifier	N/A	‘%2s’
J9	50-51	‘DB’	Noise level of North beam unit identifier	N/A	‘%2s’
K9	55-56	‘DB’	Noise level of Vertical beam unit identifier	N/A	‘%2s’
L9	60-62	‘M/S’	Spectral Width of East beam unit identifier	N/A	‘%3s’
M9	65-67	‘M/S’	Spectral Width of North beam unit identifier	N/A	‘%3s’

N9	70-72	‘M/S’	Spectral Width of Vertical beam unit identifier	N/A	‘%3s’
O9	75	‘1’	First guess propagation of East beam identifier	N/A	‘%1s’
P9	77	‘2’	First guess propagation of East beam identifier	N/A	‘%1s’
Q9	79-80	‘NN’	Wind vector error estimate identifier	N/A	‘%2s’
A10	Blank line				
A11	Blank line				

*Table 5: TDRWP MDTF of Data*

Field		Contents	Field Definition	Units	Format Read
A12	1-6	XXXXXX	Geometric altitude	Meters	‘%6d’
B12	8-10	XXX	Wind direction	Degrees	‘%3d’
C12	12-16	XXX.X	Wind speed	Meters per	‘%5.1f’
D12	18-21	.XXX	Shear	Seconds <sup>-1</sup>	‘%4.3f’
E12	23-28	-XX.XX	Radial velocity from vertical beam	Meters per second	‘%5.2f’
F12	29-33	XXX.X	Signal power from East beam	Decibels	‘%5.1f’
G12	34-38	XXX.X	Signal power from North beam	Decibels	‘%5.1f’
H12	39-43	XXX.X	Signal power from Vertical	Decibels	‘%5.1f’
I12	44-48	XXX.X	Noise level from East beam	Decibels	‘%5.1f’
J12	49-53	XXX.X	Noise level from North beam	Decibels	‘%5.1f’
K12	54-58	XXX.X	Noise level from Vertical beam	Decibels	‘%5.1f’
L12	59-63	XXX.X	Spectral width from East beam	Meters per second	‘%5.1f’
M12	64-68	XXX.X	Spectral width from North beam	Meters per second	‘%5.1f’
N12	69-73	XXX.X	Spectral width from Vertical beam	Meters per second	‘%5.1f’
O12	74-75	XXX	First guess propagation of East beam	N/A	‘%3d’
P12	76-77	XXX	First guess propagation of North beam	N/A	‘%3d’
Q12	78-80	XXX	Wind vector error estimate	Meters per second	‘%3d’

Table 6: TDRWP MDTF of Termination and Meta Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A250	1-11	'TERMINATION'	Termination identifier	N/A	'%11s'
B250	18-23	XXXXXX	Termination altitude	Meters	'%6d'
A251	1-5	XXX.X	East beam azimuth	Degrees	'%5.1f'
B251	7-11	XXX.X	North beam azimuth	Degrees	'%5.1f'
C251	13-17	XXX.X	Vertical beam azimuth	Degrees	'%5.1f'
D251	19-22	XX.X	East beam elevation	Degrees	'%4.1f'
E251	24-27	XX.X	North beam elevation	Degrees	'%4.1f'
F251	29-32	XX.X	Vertical beam elevation	Degrees	'%4.1f'
G251	34-36	XXX	First Fourier Transformation points	N/A	'%3d'
H251	38-41	XXXX	Number of time domain averages of East beam	N/A	'%4d'
I251	43-46	XXXX	Number of time domain averages of North beam	N/A	'%4d'
J251	48-51	XXXX	Number of time domain averages of Vertical beam	N/A	'%4d'
K251	53-54	XX	Number of spectral averages of East beam	N/A	'%2d'
L251	56-57	XX	Number of spectral averages of North beam	N/A	'%2d'
M251	59-60	XX	Number of spectral averages of Vertical beam	N/A	'%2d'
N251	62-66	XXX.X	Pulse repetition period of East beam	Microsecond	'%5.1f'
O251	68-72	XXX.X	Pulse repetition period of North beam	Microsecond	'%5.1f'
P251	74-78	XXX.X	Pulse repetition period of Vertical beam	Microsecond	'%5.1f'
A252	1-3	XXX	Vertical gate spacing of East beam	Meters	'%3d'
B252	5-7	XXX	Vertical gate spacing of North beam	Meters	'%3d'
C252	9-11	XXX	Vertical gate spacing of Vertical beam	Meters	'%3d'
D252	13-15	XXX	Vertical gate width of East beam	Meters	'%3d'
E252	17-19	XXX	Vertical gate width of North beam	Meters	'%3d'
F252	21-23	XXX	Vertical gate width of Vertical beam	Meters	'%3d'
G252	25-27	XXX	Maximum AC voltage	Volts	'%3d'
H252	29-31	XXX	Minimum AC voltage	Volts	'%3d'

I252	33-37	XXXXXX	Transmitted power	Kilowatts	'%5d'
J252	39-41	XXX	Noise temperature, estimated	Kelvin	'%3d'
K252	43-47	XXXXXX	Reflected power	Watts	'%5d'
L252	49-52	XXXX	Driver output power	Watts	'%4d'
M252	54-57	XXXX	Driver input power	Watts	'%4d'
N252	59-61	XXX	Transmitter temperature	Kelvin	'%3d'
O252	63-65	XXX	Enclosure temperature	Kelvin	'%3d'
P252	67	X	Flood alarm	N/A	'%1d'
Q252	69	X	Access alarm	N/A	'%1d'
R252	71-72	XX	Code bits	N/A	'%2d'
A253	1	X	Temporal median filter code of East beam	N/A	'%1d'
B253	3	X	Temporal median filter code of North beam	N/A	'%1d'
C253	5	X	Temporal median filter code of Vertical beam	N/A	'%1d'
D253	7	X	Running mean code of East beam	N/A	'%1d'
E253	9	X	Running mean code of North beam	N/A	'%1d'
F253	11	X	Running mean code of Vertical beam	N/A	'%1d'
A254	1-3	XXX	Check sum total	N/A	'%3d'
B254	5-7	XXX	Check sum total repeated	N/A	'%3d'
A255	1-4	'NNNN'	End of file flag	N/A	'%4s'

### 3.3 915-MHz DRWP

The 915-MHz DRWPs data are disseminated through REIN in the DRWP specific MDTF. Unlike the WINDS and TDRWP MDTF files, there exist no explanatory text for the data within the file. Also, due to the 80 character line limitations, a single record of data from a range gate is recorded over two lines. The first line of the file contains the file name. The first line of the header contains the identifier for the specific DRWP. The data lines include fields for an optional five beam configuration. A termination flag is given on the last line of every DRWP within the file.

```

RW012722116

RWP0001
28.40  80.60    3
15 09 29 21 16 00    0
14
10 10 9 0 0 6 6 6 0 0 2.00 2.00 3.00 0.00
0.00
170 170 42 42 1400 1400 47 47
10.3 10.3 1 2100 2100 60 60 700 700
91 1 0 0 75 75 0 0
0.130 5.9 181 0.00 0.00 -1.50 9999 9999 9 10 10
9999 9999 13 11 15 9999 9999
0.231 6.1 187 0.00 -0.10 -1.60 9999 9999 9 10 10
9999 9999 12 12 15 9999 9999
0.332 6.3 192 0.10 -0.30 -1.60 9999 9999 9 10 10
9999 9999 9 9 12 9999 9999
...
NNNN

```

Figure 3: Example of 915MHz DRWP MDTF

The tables below include the 915-MHz DRWP MDTF header, data, and termination formats. Due to the 80 character line limitations, the data format requires a single altitude gate's data be recorded over two lines. The two lines in the data format table are repeated for each of the 60 altitude gates of the 915-MHz DRWP. Data from each of the five 915-MHz DRWPs at the ER is recorded in this format.

Table 7: 915-MHz DRWP MDTF of Header Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A1	1-2	'RW'	DRWP two letter identifier	N/A	'%2s'
B1	3-4	XX	Location code	N/A	'%2s'
C1	5-7	XXX	Day of year	Day of year	'%3d'
D1	8-11	XXXX	Time (HHMM)	Hour and	'%4s'
A2	Blank Line				
A3	1-7	XXXXXXXX	DRWP Identifier	N/A	'%8s'
A4	1-5	XX.XX	Latitude of DRWP	Degree	'%5.2f'
B4	8-12	XXX.XX	Longitude of DRWP	Degree	'%6.2f'
C4	14-17	XXXX	Altitude above sea level	Meters	'%4d'
A5	1-2	XX	Consensus year	Last two digits of year	'%2d'
B5	5-6	XX	Consensus month	Month in two	'%2d'
C5	9-10	XX	Consensus day	Day of month	'%2d'
D5	13-14	XX	Consensus hour	Hours	'%2s'
E5	17-18	XX	Consensus minute	Minutes	'%2s'
F5	25-27	XXX	Number of minutes difference from Zulu time	Minutes	'%3d'
A6	1-3	XXX	Consensus averaging time period	Minutes	'%3d'
A7	1-3	XXX	Total number of records for beam #1	N/A	'%3d'
B7	6-8	XXX	Total number of records for beam #2	N/A	'%3d'
C7	11-13	XXX	Total number of records for beam #3	N/A	'%3d'
D7	16-18	XXX	Total number of records for beam #4	N/A	'%3d'
E7	21-23	XXX	Total number of records for beam #5	N/A	'%3d'
F7	26-28	XXX	Total number of records required to meet consensus for beam #1	N/A	'%3d'
G7	31-33	XXX	Total number of records required to meet consensus for beam #2	N/A	'%3d'
H7	36-38	XXX	Total number of records required to meet consensus for beam #3	N/A	'%3d'
I7	41-43	XXX	Total number of records required to meet consensus for beam #4	N/A	'%3d'
J7	46-48	XXX	Total number of records required to meet consensus for beam #5	N/A	'%3d'
K7	51-56	XXX.XX	Range where samples must fall to be acceptable for beam #1	N/A	'%6.2f'
L7	59-64	XXX.XX	Range where samples must fall to be acceptable for beam #2	N/A	'%6.2f'
M7	67-72	XXX.XX	Range where samples must fall to be acceptable for beam #3	N/A	'%6.2f'
N7	75-80	XXX.XX	Range where samples must fall to be acceptable for beam #4	N/A	'%6.2f'

A8	3-8	XXX.XX	Range where samples must fall to be acceptable for beam #5	N/A	‘%6.2f’
A9	1-4	XXXX	Number of coherent integrations (oblique)	N/A	‘%4d’
B9	7-10	XXXX	Number of coherent integrations (vertical)	N/A	‘%4d’
C9	13-15	XXX	Number of spectral averages (oblique)	N/A	‘%3d’
D9	18-20	XXX	Number of spectral averages (vertical)	N/A	‘%3d’
E9	23-26	XXXX	Pulse width (oblique)	Nanoseconds	‘%4d’
F9	29-32	XXXX	Pulse width (vertical)	Nanoseconds	‘%4d’
G9	35-38	XXXX	Inter-pulse period (oblique)	Microseconds	‘%4d’
H9	41-44	XXXX	Inter-pulse period (vertical)	Microseconds	‘%4d’
A10	1-5	XXX.X	Full scale Nyquist Doppler velocity (oblique)	Meters per second	‘%5.1f’
B10	8-12	XXX.X	Full scale Nyquist Doppler velocity (vertical)	Meters per second	‘%5.1f’
C10	15	X	Correction indicator	N/A	‘%1d’
D10	18-22	XXXXXX	Delay in getting to first range gate (oblique)	Nanoseconds	‘%5d’
E10	25-29	XXXXXX	Delay in getting to first range gate (vertical)	Nanoseconds	‘%5d’
F10	32-34	XXX	Number of range gates (oblique)	N/A	‘%3d’
G10	37-39	XXX	Number of range gates (vertical)	N/A	‘%3d’
H10	42-45	XXXX	Range gate spacing (oblique)	Nanoseconds	‘%4d’
I10	48-51	XXXX	Range gate spacing (vertical)	Nanoseconds	‘%4d’
A11	1-3	XXX	Azimuth of oblique beam #1	Degrees	‘%3d’
B11	6-8	XXX	Azimuth of oblique beam #2	Degrees	‘%3d’
C11	11-13	XXX	Azimuth of oblique beam #3	Degrees	‘%3d’
D11	16-18	XXX	Azimuth of oblique beam #4	Degrees	‘%3d’
E11	21-23	XXX	Elevation of oblique beam #1	Degrees	‘%3d’
F11	26-28	XXX	Elevation of oblique beam #2	Degrees	‘%3d’
G11	31-33	XXX	Elevation of oblique beam #3	Degrees	‘%3d’
H11	36-38	XXX	Elevation of oblique beam #4	Degrees	‘%3d’

Table 8: 915-MHz DRWP MDTF of Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A12	1-6	XX.XXX	Altitude	Kilometers	'%6.3f'
B12	9-14	XXXX.X	Wind speed	Meters per second	'%6.1f'
C12	17-19	XXX	Wind direction	Degrees	'%3d'
D12	22-28	XXXX.XX	Radial velocity for beam #1	Meters per second	'%7.2f'
E12	30-36	XXXX.XX	Radial velocity for beam #2	Meters per second	'%7.2f'
F12	38-44	XXXX.XX	Radial velocity for beam #3	Meters per second	'%7.2f'
G12	46-52	XXXX.XX	Radial velocity for beam #4	Meters per second	'%7.2f'
H12	54-60	XXXX.XX	Radial velocity for beam #5	Meters per second	'%7.2f'
I12	62-65	XXXX	Number of records in consensus for beam #1	N/A	'%4d'
J12	67-70	XXXX	Number of records in consensus for beam #2	N/A	'%4d'
K12	72-75	XXXX	Number of records in consensus for beam #3	N/A	'%4d'
A13	1-4	XXXX	Number of records in consensus for beam #4	N/A	'%4d'
B13	7-10	XXXX	Number of records in consensus for beam #5	N/A	'%4d'
C13	13-16	XXXX	Signal to noise ratio for beam #1	Decibels	'%4d'
D13	19-22	XXXX	Signal to noise ratio for beam #2	Decibels	'%4d'
E13	25-28	XXXX	Signal to noise ratio for beam #3	Decibels	'%4d'
F13	31-34	XXXX	Signal to noise ratio for beam #4	Decibels	'%4d'
G13	37-40	XXXX	Signal to noise ratio for beam #5	Decibels	'%4d'

Table 9: 915-MHz DRWP MDTF of Termination Flag

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A132	1-4	'NNNN'	Termination flag	N/A	'%4d'



### 3.4 AMPS Flight Elements

The LRFEs are used in both launch support and meteorological forecasts. The LRFE data is recorded in the MDTF which has the data in either 100 or 1,000 foot increments. In support of the meteorological forecasts, additional actual altitudes are included in the file. These altitudes are listed as either mandatory or significant levels, resulting in three separate sections of data within a LRFE file. The name of the file is the first line of the file, followed by a header, and the three data sections. The interpolated data section and the significant sections have termination flags. Like the other MDTF files, each line has an 80 character limit.

```
LR012722350
TEST NBR I8129 2ND RELEASE
RAWINSONDE AMP/LR
CAPE CANAVERAL AFS, FLORIDA
2350Z 29 SEP 15

  ALT  DIR   SPD  SHR  TEMP  DPT  PRESS  RH  ABHUM  DENSITY  I/R  V/S  VPS  PW
GEOMFT DEG   KTS /SEC DEG C DEG C   MBS  PCT  G/M3   G/M3   N  KTS  MBS  MM

   16 210    4.0 .000  27.5  25.9 1008.80  91  24.09 1154.28 398 680 33.42  0
  1000 246   16.4 .023  25.3  22.0  975.32  82  19.16 1126.81 364 677 26.39  6
  2000 270   15.6 .011  23.2  20.9  942.16  87  18.03 1096.59 351 674 24.66 12
  3000 276   16.8 .004  21.3  19.6  909.92  90  16.84 1066.31 338 672 22.88 17
...
TERMINATION          24934 GEOPFT    7600 GEOPM   400.8 MBS
TROPOPAUSE           0 FEET          .00 MB     .0 C     .0 C

MANDATORY LEVELS
GEOPFT DIR KTS  TEMP   DPT PRESS   RH

   272 222  12  27.0   23.4 1000.0  81
  1758 264  14  23.7   21.2  950.0  86
  2525 271  15  22.2   20.1  925.0  88
...
SIGNIFICANT LEVELS
GEOMFT DIR KTS  TEMP   DPT PRESS   IR  RH

   16 210    4  27.5   25.9 1008.8 398  91
   300 223   13  27.0   23.3  999.0 377  80
  3700 288   17  19.7   18.6  887.9 329  94
...
TERMINATION
034 034
```

Figure 4: Example of LRFE MDTF

The tables below include the LRFE MDTF data levels header, data, data levels termination records, mandatory levels header, mandatory levels data, significant levels header, significant levels data, and the file termination data formats. The number of data, mandatory, and significant levels are dependent upon the termination altitude of the balloon, thus the line number in tables 12, 13, 15, and 17 are relative to each section, not the line number in the file. Furthermore, the format for the data, mandatory, and significant levels are repeated for every altitude.

Table 10: LRFE MDTF of Data Header

Field #	Columns	Contents	Field Definition	Units	Format Read
A6	Blank Line				
A7	3-5	‘ALT’	Altitude of measurements	N/A	‘%3s’
B7	8-10	‘DIR’	Wind direction	N/A	‘%3s’
C7	14-16	‘SPD’	Wind speed	N/A	‘%3s’
D7	19-21	‘SHR’	Shear	N/A	‘%3s’
E7	24-27	‘TEMP’	Temperature	N/A	‘%4s’
F7	30-32	‘DPT’	Dew point temperature	N/A	‘%3s’
G7	36-40	‘PRESS’	Pressure	N/A	‘%5s’
H7	44-45	‘RH’	Relative humidity	N/A	‘%2s’
I7	47-51	‘ABHUM’	Absolute humidity	N/A	‘%5s’
J7	53-59	‘DENSITY’	Density	N/A	‘%7s’
K7	61-63	‘I\ R’	Index of refraction	N/A	‘%3s’
L7	65-67	‘V\ S’	Speed of sound	N/A	‘%3s’
M7	70-72	‘VPS’	Vapor pressure	N/A	‘%3s’
N7	75-76	‘PW’	Precipitable water	N/A	‘%2s’
A8	1-6	‘GEOMFT’	Altitude unit identifier	N/A	‘%6s’
B8	8-10	‘DEG’	Wind direction unit identifier	N/A	‘%3s’
C8	14-16	‘KTS’	Wind speed unit identifier	N/A	‘%3s’
D8	18-21	‘/SEC’	Shear unit identifier	N/A	‘%4s’
E8	23-27	‘DEG C’	Temperature unit identifier	N/A	‘%5s’
F8	29-33	‘DEG C’	Dew Point unit identifier	N/A	‘%5s’
G8	37-39	‘MBS’	Pressure unit identifier	N/A	‘%3s’
H8	43-45	‘PCT’	Relative humidity unit identifier	N/A	‘%3s’
I8	48-51	‘G/M3’	Absolute humidity unit identifier	N/A	‘%4s’
J8	55-58	‘G/M3’	Density unit identifier	N/A	‘%4s’
K8	62	‘N’	Index of refraction unit identifier	N/A	‘%1s’
L8	65-67	‘KTS’	Speed of sound unit identifier	N/A	‘%3s’
M8	70-72	‘MBS’	Vapor pressure unit identifier	N/A	‘%3s’
N8	75-76	‘MM’	Precipitable water unit identifier	N/A	‘%2s’
A9	Blank Line				

Table 11: LRFE MDTF of Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A10	1-6	XXXXXX	Geometric altitude	MSL Feet	'%6d'
B10	8-10	XXX	Wind direction	Degrees	'%4d'
C10	12-16	XXX.X	Wind speed	Knots	'%6.1f'
D10	18-21	.XXX	Shear	Seconds <sup>-1</sup>	'%5.3f'
E10	23-27	XXX.X	Temperature	Celsius	'%6.1f'
F10	29-33	XXX.X	Dew point	Celsius	'%6.1f'
G10	35-41	XXXX.XX	Pressure	Millibars	'%8.2f'
H10	43-45	XXX	Relative humidity	Percent	'%4d'
I10	47-51	XX.XX	Absolute humidity	Grams per meter <sup>3</sup>	'%6.2f'
J10	53-59	XXXX.XX	Density	Grams per meter <sup>3</sup>	'%8.2f'
K10	61-63	XXX	Index of Refraction	Index	'%4d'
L10	65-67	XXX	Velocity of sound	N	'%4d'
M10	69-73	XX.XX	Vapor pressure	Millibars	'%6.2f'
N10	75-76	XX	Precipitable water	Millimeters	'%3d'

Table 12: LRFE MDTF of Data Termination Records

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A1	1-11	'TERMINATION'	Termination unit identifier	N/A	'%12s'
B1	18-23	XXXXXX	Termination altitude	Feet	'%6d'
C1	25-30	'GEOPFT'	Geopotential altitude unit identifier	N/A	'%6s'
D1	32-37	XXXXXX	Geopotential altitude in meters	Meters	'%6d'
E1	39-43	'GEOPM'	Geopotential altitude (millibars) identifier	N/A	'%5s'
F1	45-50	XXXX.X	Geopotential altitude in Millibars	Millibars	'%6.1f'
G1	52-54	'MBS'	Millibar unit identifier	N/A	'%3s'
A2	1-10	'TROPOPAUSE'	Tropopause identifier	N/A	'%11s'
B2	13-18	XXXXXX	Tropopause altitude in feet	Feet	'%6d'
C2	21-24	'FEET'	Feet unit identifier	N/A	'%4s'
D2	27-33	XXXX.XX	Tropopause in millibars	Millibars	'%7.2f'
E2	35-36	'MB'	Millibar unit identifier	N/A	'%2s'
F2	39-43	XXX.X	Tropopause temperature	Celsius	'\$5.1f'
G2	45	'C'	Temperature unit identifier	N/A	'%1s'
H2	48-52	XXX.X	Tropopause dew point	Celsius	'%5.1f'
I2	54	'C'	Dew Point unit identifier	N/A	'%1s'
A3	Blank Line				

Table 13: LRFE MDTF of Mandatory Levels Header Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A1	1-16	'MANDATORY LEVELS'	Mandatory Levels identifier	N/A	'%17s'
A2	1-6	'GEOPFT'	Geopotential altitude unit identifier	N/A	'%7s'
B2	8-10	'DIR'	Wind direction unit identifier	N/A	'%3s'
C2	12-14	'KTS'	Wind Speed unit identifier	N/A	'%3s'
D2	17-20	'TEMP'	Temperature unit identifier	N/A	'%4s'
E2	24-26	'DPT'	Dew Point unit identifier	N/A	'%3s'
F2	28-32	'PRESS'	Pressure unit identifier	N/A	'%5s'
G2	36-37	'RH'	Relative Humidity identifier	N/A	'%2s'
A3	Blank line				

Table 14: LRFE MDTF of Mandatory Levels Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A4	1-6	XXXXXX	Mandatory altitude	MSL Feet	'%6d'
B4	8-10	XXX	Wind direction	Degrees	'%3d'
C4	1214	XXX	Wind speed	Knots	'%3d'
D4	16-20	XXX.X	Temperature	Celsius	'%5.1f'
E4	22-26	XXX.X	Dew Point	Celsius	'%5.1f'
F4	28-33	XXXX.X	Pressure	Millibars	'%6.1f'
G4	35-37	XXX	Relative humidity	Percent	'%3d'

Table 15: LRFE MDTF of Significant Levels Header Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A1	1-16	'SIGNIFICANT LEVELS'	Mandatory Levels identifier	N/A	'%17s'
A2	1-6	'GEOMFT'	Geopotential altitude unit identifier	N/A	'%7s'
B2	8-10	'DIR'	Wind direction unit identifier	N/A	'%3s'
C2	12-14	'KTS'	Wind Speed unit identifier	N/A	'%3s'
D2	17-20	'TEMP'	Temperature unit identifier	N/A	'%4s'
E2	23-26	'DPT'	Dew Point unit identifier	N/A	'%3s'
F2	28-33	'PRESS'	Pressure unit identifier	N/A	'%5s'
G2	35-37	'IR'	Index of refraction unit identifier	N/A	'%2s'
H2	40-41	'RH'	Relative Humidity unit identifier	N/A	'%2s'

Table 16: LRFE MDTF of Significant Levels Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A3	1-6	XXXXXX	Significant altitude	MSL Feet	'%6d'
B3	8-10	XXX	Wind direction	Degrees	'%3d'
C3	1214	XXX	Wind speed	Knots	'%3d'
D3	16-20	XXX.X	Temperature	Celsius	'%5.1f'
E3	22-26	XXX.X	Dew Point	Celsius	'%5.1f'
F3	28-33	XXXX.X	Pressure	Millibars	'%6.1f'
G3	35-37	XXX	Index of Refraction	N	'%3d'
H3	40-41	XXX	Relative humidity	Percent	'%3d'

Table 17: LRFE MDTF of File Termination Records

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A1	1-11	TERMINATION	Termination identifier	N/A	'%12s'
A2	1-3	XXX	File checksum	N/A	'%3s'
B2	5-7	XXX	File checksum repeated	N/A	'%3s'
A3	Blank line				

The HRFE and the Jimsphere are recorded in the HRFE MDTF and the standard output file provides data which are interpolated in 100 foot increments. Also, data from a LRFE can be reported in this format, but only the wind information is recorded. An LRFE being recorded in this format is known as an LRFE Winds Only AMPS file (LWAM). Unlike the LRFE MDTF, the HRFE MDTF does not have either Mandatory or Significant data sections. The HRFE data is segregated into 5,000 foot blocks, with an individual file containing data for each block. This architecture allows data to be transmitted from the balloon before the balloon has completed its ascent. The first line of the file contains the filename, which includes the transmission time of the block. The time of the balloon release is in the header of the file. At the end of the 5,000 foot block, a terminator flag will either state that the end of the block has been reached, or if the balloon has reached its highest altitude.

```

HR010861830
TEST NBR G6144
HI-RES AMPS WIND DAT
CAPE CANAVERAL AFS, FL.
1737Z 27 MAR 07

  ALT  DIR   SPD  SHR  ASCENT  DATA
GEOMFT DEG   KTS /SEC  F/S    QUALITY

  45100 288   59.1 .021  14.5      1
  45200 287   56.2 .052  14.7      1
  45300 288   55.1 .026  14.9      1
  ...
  50000 270   24.3 .037  12.0      1
END OF BLOCK      50000
036 036
NNNN

```

Figure 5: Example of HRFE MDTF

The winds only flight elements use the fixed MDTF header that is outlined in Table 3. Tables 18-20 describe the MDTF for the data header, the levels of data, and the termination or end of block data records.

Table 18: Winds Only AMPS Flight Element MDTF of Header Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A6	Blank Line				
A7	3-5	‘ALT’	Altitude of measurements identifier	N/A	‘%3s’
B7	8-10	‘DIR’	Wind direction identifier	N/A	‘%3s’
C7	14-16	‘SPD’	Wind Speed identifier	N/A	‘%3s’
D7	19-21	‘SHR’	Shear identifier	N/A	‘%3s’
E7	24-29	‘ASCENT’	Ascent identifier	N/A	‘%6s’
F7	32-35	‘DATA’	Data Quality identifier	N/A	‘%4s’
A8	Blank Line				
A8	1-6	‘GEOMFT’	Altitude unit identifier	N/A	‘%6s’
B8	8-10	‘DEG’	Wind direction identifier	N/A	‘%3s’
C8	14-16	‘KTS’	Wind speed unit identifier	N/A	‘%3s’
D8	18-21	‘/SEC’	Shear unit identifier	N/A	‘%4s’
E8	24-26	‘F/S’	Ascent unit identifier	N/A	‘%3s’
F8	31-37	‘QUALITY’	Data Quality identifier	N/A	‘%7s’
A9	Blank Line				

Table 19: Winds Only AMPS Flight Element MDTF of Data

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A10	1-6	XXXXXX	Altitude	Feet	‘%6d’
B10	8-10	XXX	Wind Direction	Degrees	‘%3d’
C10	12-16	XXX.X	Wind Speed	Knots	‘%5.1f’
D10	18-21	.XXX	Shear	Seconds <sup>-1</sup>	‘%4.3f’
E10	23-27	XXX.X	Ascent	Feet per second	‘%5.1f’
F10	32-34	X	An “T” in column 32 for interpolated data or layer depth in hundreds of feet in column 34	N/A	‘%3s’ ‘%3d’

Table 20: Winds Only AMPS Flight Element MDTF of Termination Records

Field #	Columns	Contents	Field Definition	Units	Format Read Statement
A1	1-13	‘END OF BLOCK’ Or ‘TERMINATION’	End of block or Termination flag	N/A	‘%13s’
B1	18-23	XXXXXX	Altitude at the end of the block or at termination	Feet	‘%6d’
A2	1-3	XXX	Checksum total	N/A	‘%3d’
B2	5-7	XXX	Repeated checksum total	N/A	‘%3d’

### 3.5 4DLSS

As stated in the instrumentation section, 4DLSS has two systems; the CGLSS and LDAR. Each system has its own data formats. However, only CGLSS is shared via MIDDS and REIN. Data from the CGLSS is recorded in three different files: accumulated lightning strikes for the last hour (MDL), lightning strikes for 24 hours from the previous days (MEL), and daily accumulated lightning strikes from MD files (ML). Each of these files have a different file naming convention. MDL files following this naming convention: MD.YYYYCCC-HH, where YYYY is the year, CCC is the day of the year, and HH is the hour of accumulated lightning strikes. MEL files following this naming convention: ME.YYCCC-HHMM, where YY is the two digit year code, CCC is the day of the year, HH is the hour and MM is the minute of the file creation. ML files following this naming convention: MLYYYYCCC, where YYYY is the year and CCC is day of the year. All three files follow the same format. An example of this file format is shown below:

USE CAUTION: ENSURE DATA IS REASONABLE								
DATA MAY NOT BE CURRENT								
(UPDATED ON 2017054 AT 19:04:42 GMT)								
DAY[CYD]	HMS[HMS]	LAT[DEG]	LON[DEG]	NSTR	RS	DF1	DF2	FLAG
-----	-----	-----	-----	-----	-----	-----	-----	-----
2017054	182957	28.4938	78.2218	47.4	0	1	6	+
Number of matches found = 1								

*Figure 6: Example of CGLSS MIDDS Format*

The CG format includes a header with the time of file creation, and data fields in the main body of the file that contain the date, time, latitude, longitude, signal strength in kiloamps (NSTR), event classification (RS), first detecting sensor (DF1), second detecting sensor (DF2), and quality flag (FLAG).

Both CG and CC data are available via the KSC weather archive in the American Standard Code for Information Interchange (ASCII) format. The data on the KSC weather is not quality controlled. The KSC Weather Archive CC data format includes the date and time of a measured event, down to a millionth of a second. The file format has an event flag which is used to identify the system that measured the lightning strike. The specific system identifier also informs users if the lightning event was a cloud-to-cloud (4DLSS) or cloud-to-ground (CGLSS) event. A third identifier flag, CAL, is used to show when the system is being recalibrated. These files also have a large header that includes language about the system, how to interpret the location data, and how to interpret the Event Type flags.



The following Lightning Detection and Ranging (LDAR) and Cloud to Ground Lightning Surveillance (CGLSS) data sets are displayed in a tab delimited format:

The EVENT TYPE field will display the data type as an LDAR EVENT, GGLSS EVENT or CAL EVENT. A CAL EVENT is a locally generated simulated lightning event used to validate the operation status of the Kennedy Space Center's LDAR System.

The X, Y and Z coordinates are in reference to the Kennedy Space Center's LDAR Central Site located at Latitude 28 32 18.55N and Longitude 80 38 33.48W

JDAY	TIME(UTC)	X(M)	Y(M)	Z(M)	EVENT TYPE
183	00:00:20:133667	-0132209	-0095197	+10521	4DLSS EVENT
183	00:00:20:199356	-0134280	-0098734	+12482	4DLSS EVENT
183	00:00:20:228561	-0128908	-0090532	+07224	4DLSS EVENT
183	00:00:20:246746	-0033201	+0132558	-01438	CGLSS EVENT
183	00:00:20:258878	-0127219	-0088803	+09487	4DLSS EVENT
183	00:00:20:334670	-0029974	+0111586	-01019	CGLSS EVENT
183	00:00:21:979626	-0001300	-0001500	+00500	CAL EVENT
183	00:00:24:212036	-0135174	+0018812	-01427	CGLSS EVENT
183	00:00:24:236536	-0133614	+0018580	-01394	CGLSS EVENT
183	00:00:24:295239	-0131873	+0016984	-01353	CGLSS EVENT
183	00:00:24:400512	-0136476	+0019925	-01458	CGLSS EVENT
...					

Figure 7: Example of 4DLSS CC KSC Weather Archive Format

The KSC Weather Archive CG data format consists of the date of the lightning strike, the time of the lightning strike to the ten millionth of a second, latitude, longitude, the signal strength, the event type, , the semi-major and semi-minor axes, ellipse angle, and a field that lists all sensors that measured the lightning event.

02/15/2017	03:12:12.4259955	29:51:06	-79:22:26	-42.5	0 r	07.20	00.80	044	1,2,4,5,6
02/15/2017	04:00:50.1067767	29:40:58	-79:25:03	37.6	0 r	05.90	00.70	048	2,5,6
02/15/2017	04:29:46.6879559	28:54:20	-79:09:49	-23.5	0 r	04.40	00.60	074	1,2,5,6
02/15/2017	04:40:28.4912558	29:21:41	-79:13:58	-40.5	0 r	04.50	00.50	060	1,2,4,5,6
02/15/2017	04:43:03.6909311	28:55:04	-79:03:14	27.8	0 r	09.30	01.00	069	2,6
02/15/2017	04:52:04.5960794	28:55:45	-79:05:26	-30.7	0 r	04.00	00.50	075	1,2,4,5,6
02/15/2017	04:54:27.8691981	28:54:41	-79:07:56	-25.0	0 r	04.20	00.60	075	1,2,4,5,6
02/15/2017	04:57:13.6232418	28:58:38	-78:55:29	-33.2	0 r	04.90	00.60	074	1,2,4,5,6
02/15/2017	04:57:13.8708680	29:08:59	-78:33:32	-67.4	0 r	08.90	00.80	071	1,2,4,5,6

Figure 8: Example of 4DLSS CG KSC Weather Archive Format

### 3.6 MERLIN

The data from MERLIN will replace the data from 4DLSS once MERLIN is operationally accepted. Like 4DLSS, MERLIN produces both CC and CG data files. The MERLIN CC and CG data files will be stored on the KSC Weather Archive and will follow the same format as the KSC Weather Archive 4DLSS CC and CG files. The MERLIN CC and CG KSC Weather Archive data file format includes date, time to the ten millionths of a second, the location data, the signal strength, the event type, the semi-major and semi-minor axes, ellipse angle, and a field that lists all sensors that measured the lightning event. There is no header in the file format.

06/10/2016	14:10:10.6454637	26:34:01	-87:24:42	-27.1	0	r	02.10	00.30	063	100,101,102,103,104,107
06/10/2016	14:10:15.4461190	26:50:24	-77:04:41	-73.4	0	r	00.20	00.10	067	100,102,103,104,106,107,108,109
06/10/2016	14:10:15.5996419	26:49:51	-77:04:09	-55.6	0	r	00.20	00.10	067	100,102,103,104,106,107,108,109
06/10/2016	14:10:16.0138702	26:50:24	-77:04:46	-17.7	0	r	00.70	00.20	047	103,104,106,107,109
06/10/2016	14:10:19.1649278	27:17:07	-84:51:07	-58.8	0	r	00.70	00.20	059	100,101,103,104,106
06/10/2016	14:10:19.1860772	27:17:02	-84:51:08	-19.5	0	r	00.60	00.20	061	100,101,102,103,104,106
06/10/2016	14:10:19.2111044	27:17:08	-84:51:05	-37.5	0	r	00.60	00.20	060	100,101,102,103,104,106,107
06/10/2016	14:10:19.2352152	27:17:07	-84:51:05	-22.3	0	r	00.60	00.20	060	100,101,102,103,104,106,107
06/10/2016	14:10:19.2526206	27:17:08	-84:51:04	-24.1	0	r	00.60	00.20	060	100,101,102,103,104,106,107
06/10/2016	14:10:19.3154620	27:17:00	-84:52:57	-20.7	0	r	00.60	00.20	056	100,101,102,103,104,106,107
06/10/2016	14:10:19.3807388	27:21:15	-84:45:11	15.3	0	r	02.00	00.30	035	101,102,103,106
06/10/2016	14:10:19.8807928	26:45:04	-78:09:27	10.4	0	r	00.50	00.20	041	102,104,106,109
06/10/2016	14:10:21.1898736	27:13:28	-78:20:05	9.2	0	r	00.60	00.10	037	103,104,106,107,109
06/10/2016	14:10:27.5821596	27:14:29	-78:22:05	11.0	0	r	00.30	00.10	047	100,102,103,104,106,107,109
...										

Figure 9: Example of MERLIN CC and CG KSC Weather Archive Format

Once operationally accepted, MERLIN's CG data will be the same format as the 4DLSS CGLSS data format. Also upon operational acceptance, MERLIN's CG data will be sent to MIDDs and REIN for dissemination.

### 3.7 LPLWS –field mill & rain gauge network

The LPLWS field mill electric potential data is not currently available in MDTF. The data is in a binary file due to the large size of data within each file. Because binary files can't be easily visualized by ASCII characters, an example figure of the data format is not included in this report. The rain gauge data measured by the field mills are not currently available in the MDTF. The rain gauge data is available through the KSC weather archive in an ASCII format. The file provides hourly total accumulation for each field mill for a single day in local time.

Rain Gauge Data / 01-Dec-2016 Daily Report																									
Mill	Hour	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
01	01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02	02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04	04	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05	05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06	06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
07	07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08	08	0.05	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09	09	0.02	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
...																									

Figure 10: Example of LPLWS Field Mill Rain Gauge Format

### *3.8 ER C-Band Weather Radar*

The ER C-Band Weather Radar data is recorded in a binary format that is not available from the KSC Weather Archive. The data is available through REIN in a binary format compatible with the Man-computer Interactive Data Access System (McIDAS). The McIDAS software interprets the binary format and displays the radar reflectivity data. However, the binary data can't be easily visualized by ASCII characters, thus an example figure is not included in this report.

## **4.0 Proposed Format Updates**

This section gives an overview of proposed data formats which have been generated by MSFC Natural Environments Branch (EV44) and approved by the MSICWG. This document does not contain detailed tables describing the proposed formats because the implementation of these formats has not been solidified yet.

### *4.1 WINDS Network, including LC39-B Met Instrumentation*

The proposed WINDS Network format is very similar to the current MDTF. The name of the file will remain the same as the current WINDS MDTF naming convention. Each line of data corresponds to a single height from the respective tower. The largest differences between the MDTF and the proposed format include changing the file format to a Comma Separated Variable (CSV) format using “-999.0” as a no data flag through the file, abbreviating the header to three lines, and adding fields to accommodate for new instruments being added in the WINDS Network upgrade, such as diffuse radiation and reflected radiation at LC39-B. Other changes to the format include adding fields for latitude and longitude, and reordering the heights of a tower to go from lowest to highest.

```

WT010711602 ,CCAFS/KSC ,WIND TOWER DATA,1602Z,11,MAR,16,,,,,,,,,,,,,
TOWER,LAT,LON,HGT,AV,01 MIN AVG DIR,01 MIN AVG SPD,01 MIN PEAK DIR,01 MIN PEAK SPD,10 MIN PEAK DIR,10 MIN PEAK SPD,DEV,TMP,DIF,DP,RH,PRE,DIFRAD,REFRAD,SLTEMP,SLMOIST
UNITS,DEG,DEG,FT,MIN,DEG,KTS,DEG,KTS,DEG,KTS,DEG,F,F,F,%,MB,W/M2,W/M2,F,MM
108,-999.0000,-999.0000,06,01,-999,-999,-999,-999,-999,-999,77.4,-999.0,-999.0,-999,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
108,-999.0000,-999.0000,12,01,139,7,151,15,140,19,22,-999.0,-999.0,-999.0,-999,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
108,-999.0000,-999.0000,54,01,141,14,141,19,142,23,11,75.0,-2.4,-999.0,-999,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,132,01,157,21,157,25,157,26,4,73.7,-999.0,62.8,69,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,133,01,145,17,137,23,157,25,4,74.2,-999.0,61.2,64,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,134,01,153,12,153,17,155,21,3,73.7,-999.0,59.8,62,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,257,01,156,22,153,24,153,26,3,72.7,-999.0,59.8,64,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,258,01,140,19,145,23,144,25,4,73.1,-999.0,61.1,66,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,259,01,152,12,153,17,154,19,2,72.8,-999.0,60.0,64,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,382,01,161,22,154,24,159,26,2,72.0,-999.0,57.4,60,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,383,01,144,19,136,23,149,26,3,72.3,-999.0,60.6,67,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,384,01,154,8,160,12,147,13,3,72.2,-999.0,59.9,65,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,457,01,158,22,153,24,157,26,2,71.6,-999.0,60.3,68,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,458,01,146,19,149,23,145,26,3,71.9,-999.0,60.4,67,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
39 B NW,-999.0000,-999.0000,459,01,192,1,193,7,165,9,47,72.0,-999.0,59.5,65,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0
...

```

*Figure 11: Example of Proposed WINDS Format*

The proposed TDRWP format is very similar to the current MDTF, but includes descriptors for the metadata, space delimited values in the main body of data, and fields to accommodate for a four beam configuration. The first line of the file includes the date and time of when the profile was created. Note that the metadata has moved from the footer to the header in the format. The metadata is contained in three lines: one for descriptors of data, one for units, and one for data values. The name of the file will remain the same as the current TDRWP MDTF naming convention. In the figure below, the three metadata lines have been wrapped so that they could fit onto one page.

Figure 12: Example of Proposed KSC TDRWP Format

### 4.3 915-MHz DRWP

The proposed 915-MHz DRWP format has several key changes from the current MDTF. All of the data that is currently in the MDTF is retained in the proposed format. The largest differences entail that an individual file would be created for each DRWP, rather than the current practice of putting data from all available DRWPs into one MDTF file, and the addition of text in the header to provide descriptors for data values and units. Additional proposed changes include making the header only three lines, one for value descriptors, one for units, and one for data values. The naming convention for the proposed format is RWIICCCHHMM, where II is the identifier for the specific 915-MHz DRWP, CCC is the day of the year, HH is the hour, and MM is the minute of the profile generation. In the figure below, the three lines of the header have been wrapped to fit onto one page. The first line of the proposed file includes the DRWP identifier, date, and profile creation time. The main body of data below the header will have two lines for data descriptors and units. Each range gate's data is no longer split between two lines; instead all data from a range gate is one line and the data is space delimited.

DRWP 1 16 03 25 1946																	
R_Lat	R_Lon	R_Alt	Year	Mon	Day	Hr	Min	Sec	TDiff	Con_Avg_Per	#_rec_1	#_rec_2					
28.40	80.60	3	16	03	25	19	46	14	0	14	10	10					
#_rec_3	#_rec_4	#_rec_5	Req_1	Req_2	Req_3	Req_4	Req_5	Con_1	Con_2	Con_3	Con_4	Con_5					
9	0	0	6	6	6	0	0	2.00	2.00	3.00	0.00	0.00					
#_obl_coh	#_ver_coh	#_obl_spc	#_ver_spc	obl_pul_wid	ver_pul_wid	obl_per	ver_per	obl_nyq	ver_nyq	Cor_ind	obl_del	ver_del					
170	170	42	42	1400	1400	47	47	10.3	10.3	1	2100	2100					
#_obl_gat	#_ver_gat	obl_gat_spc	ver_gat_spc	azi_1	azi_2	azi_3	azi_4	ele_1	ele_2	ele_3	ele_4						
60	60	700	700	91	1	0	0	75	75	0	0						
ALT	SPD	DIR	RV1	RV2	RV3	RV4	RV5	NR1	NR2	NR3	NR4	NR5	SNR1	SNR2	SNR3	SNR4	SNR5
KM	M/S	DEG	M/S	M/S	M/S	M/S	M/S	N/A	N/A	N/A	N/A	N/A	dB	dB	dB	dB	dB
0.130	5.5	200	0.00	-0.50	-1.40	9999	9999	6	7	7	9999	9999	14	13	10	9999	9999
0.231	4.5	203	-0.10	-0.50	-1.20	9999	9999	7	7	7	9999	9999	14	15	12	9999	9999
0.332	3.9	204	-0.10	-0.50	-1.10	9999	9999	6	7	7	9999	9999	12	14	11	9999	9999
0.434	3.2	216	-0.20	-0.60	-0.90	9999	9999	6	7	7	9999	9999	11	12	10	9999	9999
0.535	3.0	231	-0.20	-0.80	-0.70	9999	9999	6	7	7	9999	9999	8	10	8	9999	9999
...																	

Figure 13: Example of Proposed 915-MHz DRWP format

#### 4.4 LRFE

The proposed LRFE file format is similar to the current MDTF. All data is retained from the MDTF and the additional data fields added are ascent, latitude and longitude. The largest differences are the restructuring of the three sections of data. A proposed identifier field is added to the beginning of each line to show if the data from that altitude is either interpolated or from a mandatory or significant altitude. Thus, the additional termination flags are no longer needed. The data fields have been rearranged to include fields from all three sections and a no data flag, “-999”, is used if that field does not pertain to that type of level. For example, mandatory altitudes require geopotential feet but not shear, thus a “-999” flag is given for shear. The naming convention for the proposed format follows the same convention as the LRFE MDTF.

LR012722350 201509292350 CCAFS																		
RAWINSONDE AMP/LR TEST NBR A1806 WS1																		
ID	ALT	ALT	DIR	SPD	SHR	ASCENT	TEMP	DPT	PRESS	RH	ABHUM	DENSITY	I/R	V/S	VPS	PW	LATITUDE	LONGITUDE
	GEOMFT	GEOPFT	DEG	KTS	/SEC	F/S	DEGC	DEGC	MBS	PCT	G/M3	G/M3	N	KTS	MBS	MM	DEGREES	DEGREES
I	16	-999	210	4.0	-999	-999	27.5	25.9	1008.80	91	24.09	1154.28	398	680	33.42	0	34.9286	-117.9033
I	1000	-999	246	16.4	.023	-999	25.3	22.0	975.32	82	19.16	1126.81	364	677	26.39	6	-999.0000	-999.0000
I	2000	-999	270	15.6	.011	-999	23.2	20.9	942.16	87	18.03	1096.59	351	674	24.66	12	-999.0000	-999.0000
I	3000	-999	276	16.8	.004	-999	21.3	19.6	909.92	90	16.84	1066.31	338	672	22.88	17	-999.0000	-999.0000
I	4000	-999	290	18.2	.007	-999	19.6	18.1	878.55	91	15.35	1036.14	323	670	20.74	22	-999.0000	-999.0000
I	5000	-999	284	19.8	.004	-999	18.0	17.2	848.10	95	14.61	1005.90	312	668	19.63	27	-999.0000	-999.0000
...																		
M	-999	758	8	9.0	-999	-999	16.8	7.3	1000.00	54	-999.00	-999.00	-999	-999	-999.00	-999	-999.0000	-999.0000
M	-999	2182	79	10.0	-999	-999	12.6	5.6	950.00	62	-999.00	-999.00	-999	-999	-999.00	-999	-999.0000	-999.0000
M	-999	2915	94	12.0	-999	-999	10.8	4.9	925.00	67	-999.00	-999.00	-999	-999	-999.00	-999	-999.0000	-999.0000
...																		
S	800	-999	8	8.0	-999	-999	16.6	7.2	998.50	54	-999.00	-999.00	313	-999	-999.00	-999	-999.0000	-999.0000
S	3900	-999	103	15.0	-999	-999	8.2	4.2	892.40	76	-999.00	-999.00	285	-999	-999.00	-999	-999.0000	-999.0000
S	4100	-999	103	14.0	-999	-999	7.6	3.8	885.80	77	-999.00	-999.00	283	-999	-999.00	-999	-999.0000	-999.0000
...																		
NNNN																		

Figure 14: Example of Proposed LR Format

#### 4.5 AMPS Winds Only Flight Elements

The proposed AMPS Winds Only format is similar to the HRFE MDTF. The same naming convention used by HRFE MDTF is used for the proposed AMPS Winds Only format. The largest differences entail including latitude and longitude and space delimited values; as well as condensing first line relative to the MDTF header.

LWAM 16 NOV 19 2257								
ALT	DIR	SPD	SHR	ASCENT	DATA	LATITUDE	LONGITUDE	
GEOMFT	DEG	KTS	/SEC	F/S	QUALITY	DEGREES	DEGREES	
16	0	.0	.999	99.9	I	-999.0000	-999.0000	
100	281	1.8	.999	99.9	I	-999.0000	-999.0000	
200	281	3.6	.999	99.9	I	-999.0000	-999.0000	
300	281	5.4	.053	17.2	1	-999.0000	-999.0000	
400	276	8.1	.046	17.2	1	-999.0000	-999.0000	
500	279	10.0	.034	17.9	1	-999.0000	-999.0000	
...								

Figure 15: Example of Proposed AMPS Winds Only Balloons Format



#### 4.6 MERLIN

No proposed data changes are being suggested by the MSICWG at this time due to MERLIN being a newly operational instrument.

#### 4.7 LPLWS -field mill & rain gauge network

As per the discussion from the December 2016 MSICWG meeting, the scientific community is satisfied with the binary files produced by the LPLWS field mills. However, the engineering and launch communities have expressed a desire to see the LPLWS field mill data at a coarser one minute resolution compared to the current one millionth of a second resolution. The MSICWG community proposes that the binary files continue to be produced and disseminated as they are currently, as well as one minute LPLWS field mill data be disseminated through REIN. The figure below illustrates the proposed format for the one minute data. A file would be created once every five minutes and would contain the electric potential gradient of each available field mill for each minute. The file would also be in the CSV format. The naming convention of the proposed format would be LPCCCHHMM, where LP stands for LPLWS Processed data, CCC is day of the year, HH is hour, and MM is the processed minute of the first minute in the files.

```
Site,0:00,0:01,0:02,0:03,0:04,Standard Errors
Field Mill 1,-748.79,-779.61,-731.48,-569.72,-469.25,2.00 S Lat M
Field Mill 2,-295.55,-298.06,-285.97,-224.47,-252.64,2.00 S Lat M
Field Mill 4,-13.92,-19.97,-19.08,15.71,32.18,2.00 S Lat M
Field Mill 5,34.13,31.84,29.28,51.67,65.65,2.00 S Lat M
Field Mill 6,96.55,83.84,85.56,108.75,115.93,2.00 S Lat M
...
```

Figure 16: Example of Proposed LPLWS Field Mill Electric Potential Gradient Format

Each field mill is also equipped with a rain gauge. The proposed rain gauge data would be distributed once per day through REIN, with all of a given day's data in one file. The proposed format of this file would be CSV and would include the latitude, longitude, a comment field, hourly total rainfall accumulation, and daily rainfall accumulation. The hourly data would be reported in UTC. Also, the latitude and longitude data can be cross referenced with the electric potential gradient data files as both share the same field mill identifiers. The naming convention of the proposed format would be LGYYYYCCC, where LP stands for LPLWS Rain Gauge data, YYYY is the year, and CCC is day of the year.

```

RG010710000,KSC,FIELD MILL RAIN GAUGES,0000Z,11 ,MAR,16,,,,,,,,,,,,,,,,,,,,,
Site,Latitude,Longitude,Geod.  Ht.,1800,1900,2000,2100,2200,2300,0000,0100,0200,0300,0400,0500,0600,0700,0800,0900,1000,1100,1200,1300,1400,1500,1600,1700,Total,Comment
Field Mill 1,28 42 13.0798,279 19 53.1521,-26.4,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.01,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.03,Rain Gauge
Field Mill 2,28 41 15.1649,279 16 49.7497,-27,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,Rain Gauge
Field Mill 5,28 39 29.4639,279 18 02.3130,-27.08,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,Rain Gauge
...

```

*Figure 17: Example of Proposed LPLWS Field Mill Rain Gauge Format*

#### *4.8 ER C-Band Weather Radar*

Data from the ER C-Band Weather Radar is not being considered for any format changes at this time, as many users at JSC, KSC, and the ER would require a software change from McIDAS to view the data.

## 5.0 Data Networks

This section provides overview diagrams and descriptions of the systems used to process and distribute weather data by members of the MSICWG.

### 5.1 ER MIDDS and REIN System

The ER and KSC work collaboratively to gather data from their respective sources. At Cape Weather Station A, the balloon data is gathered by the Prime AMPS servers and sent to the Prime Meteorological Systems Computer (MSC) servers to convert the file format to the MDTF. Once converted, the Prime MSC server sends the data to the respective Prime REIN 1 or REIN 2 server for dissemination, the Meteorological Interactive Data Display System (MIDDS) Server at the Morrell Operations Center (MOC), and the Delta Operations Center (DOC). On Day-of-Launch (DOL), the TDRWP data is edited at Cape Weather Station A, then sent to the MIDDS Server at the MOC. The MIDDS server at the MOC and the Eastern Range Dispersion Assessment System (ERDAS) also collects the wind tower data from the WINDS, the 915-MHz DRWP data, Field Mill data, and the MERLIN CG data. Currently MIDDS sends WINDS, 915-MHz TDRWP, CG, and LRFE to the Prime REIN 1. REIN 1 and REIN 2 each have three servers: an Internal REIN, De-Militarized Zone (DMZ) server, and External REIN. Each server has different security settings and data dissemination schedules. For example, the Internal server obtains data in near real time from Cape Weather Station A and disseminates the data continuously and immediately to the Air Force Weather Agency, MSFC, and JSC. External REIN on REIN 1 and REIN 2 are used to send data to both government as well as commercial users on Day-of-Launch and other specified periods of time.

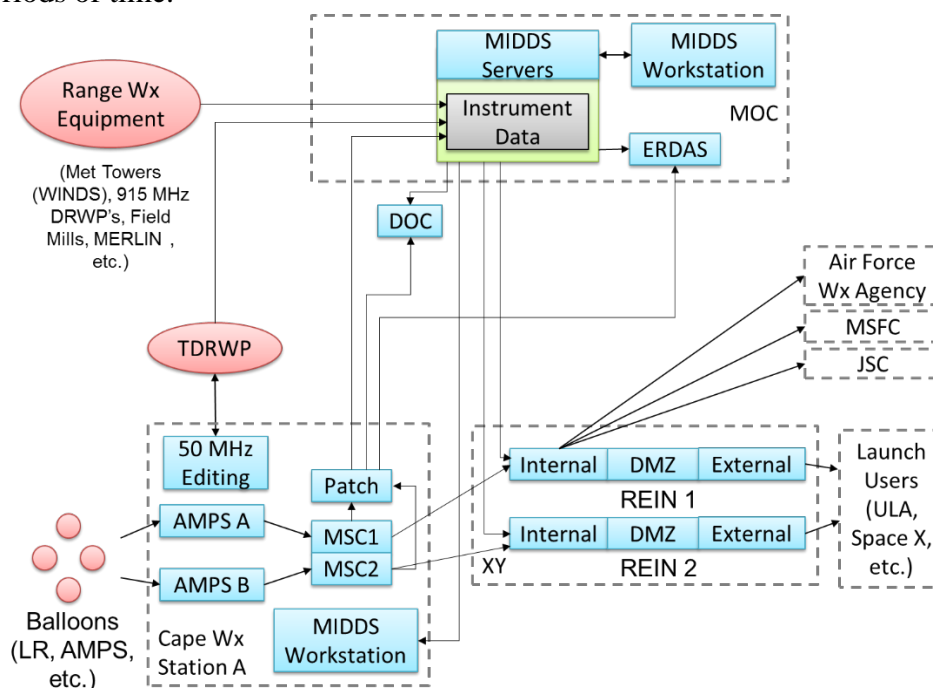


Figure 18: ER MIDDS and REIN Network and System

## 5.2 MSFC Natural Environments System

The MSFC Natural Environments System has two means of getting data: a 56 kilobyte (kB) dedicated line to the REIN 1 server at CCAFS and a redundant, secured internet line from JSC. JSC sends the same MDTF data that is sent from REIN which provides a backup source of data for MSFC. Both REIN 1 and JSC use Local Data Manager (LDM) to disseminate the data to MSFC. Once the data pass through the Huntsville Operations Support Center (HOSC) firewall, the data is routed to the two heritage physical computers for archival. The primary computer receives data from REIN and the secondary computer receives data from the redundant line to JSC. The two heritage computers were configured for the MIDDS and use McIDAS as part of the archival process to extract data from files downloaded by LDM. However, no other capabilities of McIDAS, such as visualization, are used by MSFC. As of January 2017, one virtual machine (VM) exists to both archive data and provide support for Day-of-Launch activities. The VM does not use McIDAS software as more cost efficient methods were developed by MSFC Natural Environments to extract and archive data from the files downloaded by LDM. MSFC archives AMPS LRFE, AMPS HRFE, Jimsphere, Tower, TDRWP, and 915-MHz DRWP data in the MDTF. JSC, KSC, and the ER not only archive these same files in the MDTF, but also receive lightning and C-band radar data in McIDAS-specific binary files (MD).

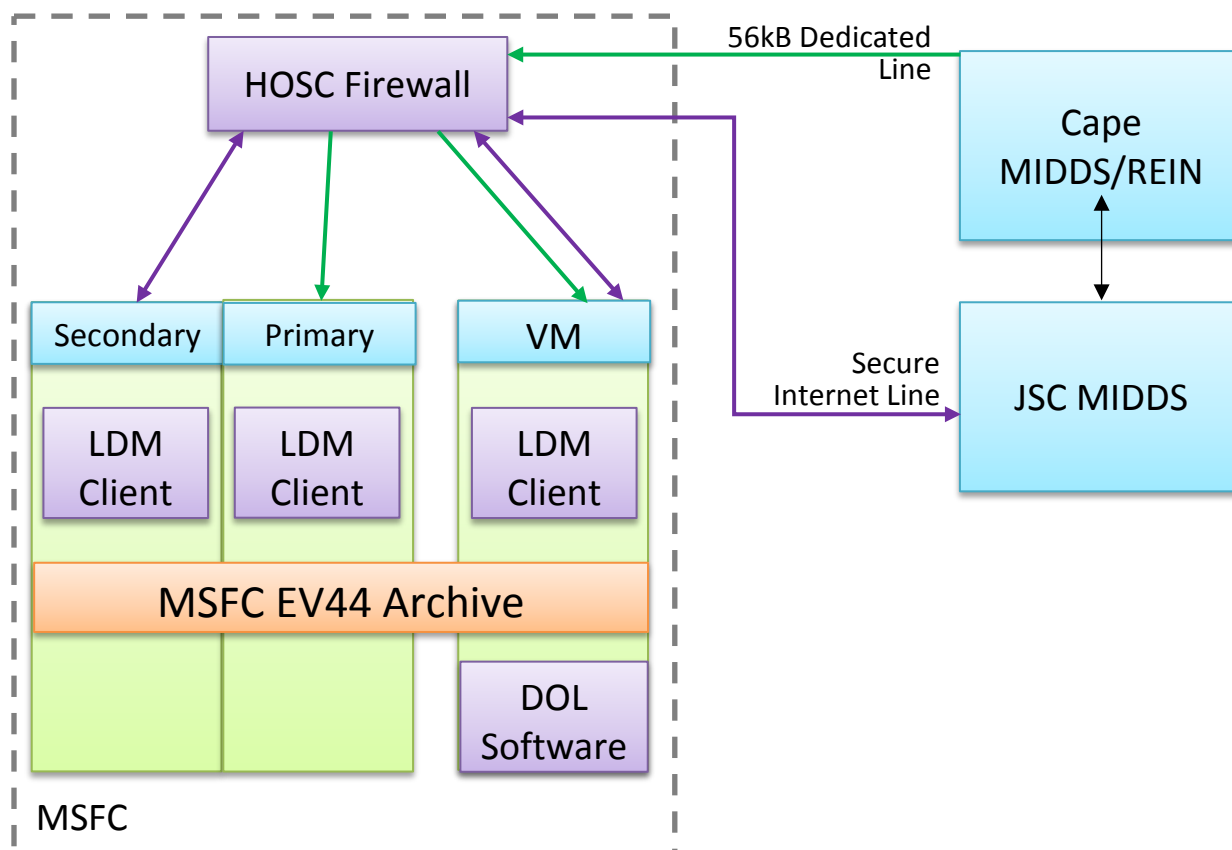


Figure 19: MSFC Natural Environments Network Systems

### 5.3 JSC MIDDS System

JSC is connected to both REIN servers at the ER as well as the secondary computer at MSFC. JSC receives data from REIN 1 and REIN 2 through a 1 Megabyte (MB)/sec portion of a 3 MB/sec redundant line. While JSC is connected to MSFC, JSC's servers are currently configured to only send data to MSFC. Once data from REIN 1 and REIN 2 pass through the Mission Control Center Firewall, LDM and the Abstract Data Distribution Environment (ADDE) disseminate the data. ADDE is the software used to share and distribute MD files, allowing SMG to download graphical files, such as C-band radar, and view the files using McIDAS. LDM is used by the Mission Control Center (MCC) weather distribution to download MDTF files and send them to the JSC MIDDS server. Once the JSC MIDDS server downloads the MDTF files, the JSC MIDDS LDM server puts the data in a queue for the MSFC LDM client to download the files as a means for redundant data for MSFC. The MCC weather distribution also passes the data to the MCC Processing and Day of Launch Initialization Load Update (DOLILU) Generation to provide MDTF files in support of DOL activities.

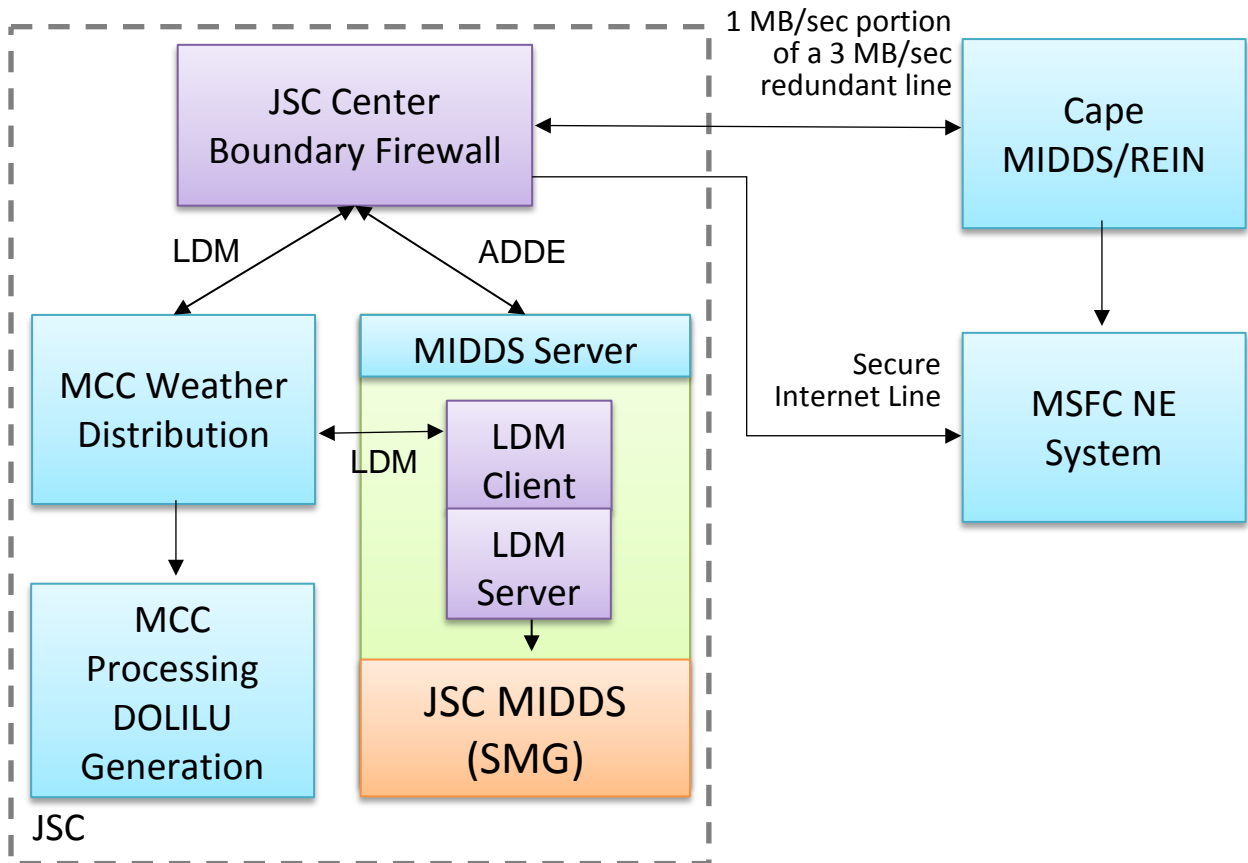


Figure 20: JSC MIDDS Network and System

## Appendix A: Acronyms

4DLSS	4 Dimensional Lightning Surveillance System
ADDE	Abstract Data Distribution Environment
AMPS	Automated Meteorological Profiling System
AMU	Applied Meteorology Unit
CCAFS	Cape Canaveral Air Force Station
CSV	Comma Separated Variable
DMZ	De-Militarized Zone
DOC	Delta Operations Center
DOL	Day of Launch
DOLILU	Day of Launch Initialization Load Update
DRWP	Doppler Radar Wind Profiler
ER	Eastern Range
ERDAS	Eastern Range Dispersion Assessment System
GPS	Global Positioning System
HOSC	Huntsville Operations Support Center
HRFE	High Resolution Flight Element
KSC	Kennedy Space Center
LC39B	Launch Complex 39 B
LDM	Local Data Manger
LPLWS	Launch Pad Lightning Warning System
LRFE	Low Resolution Flight Element
LWAM	Low Resolution Flight Element Winds Only AMPS
MCC	Mission Control Center
McIDAS	Man computer Interactive Data Access System
MERLIN	Mesoscale Eastern Range Lightning Information Network
MIDDS	Meteorological Interactive Data Display System
MOC	Morrell Operations Center
MSC	Meteorological Systems Computer
MSFC	Marshall Space Flight Center
MSICWG	Meteorological Support Interface Control Working Group
NASA	National Aeronautics and Space Administration
REIN	Range External Interface Network
SLS	Space Launch System
SMG	Spaceflight Meteorology Group
TDRWP	Tropospheric Doppler Radar Wind Profiler
USAF	United States Air Force
VM	Virtual Machine
WINDS	Weather Information Network Display System

## **Appendix B: References**

Brenton, James, “EV44 Natural Environments New Archive System”, Jacobs ESSSA Group for NASA, 10 October 2016, ESSSA-FY16-2876

Huddleston, Lisa, “KSC Weather Archive.” NASA, 2 August 2016.  
<http://kscwxarchive.ksc.nasa.gov/>

Roberts, Barry, “A Review of DOLILU Meteorological Data requirements and the MIDDs Network Infrastructure for EM01”, 27 May 2014, Presentation.